Undergraduate Laboratory Safety Exam

STUDY GUIDE

&

PRACTICE QUESTIONS

WINTER 2008

Sheila Kennedy, CHO

John Palmer, PhD

Chemistry & Biochemistry

University of California, San Diego

TABLE OF CONTENTS

STUDY GUIDE & PRACTICE QUESTIONS for Undergraduate Laboratory Safety Exam

Department of Chemistry & Biochemistry
University of California, San Diego

INTRODUCTION

ALL students in introductory chemistry lab classes (Chemistry 6BL, 100A, 143A and 143AM) are required to demonstrate an understanding of general laboratory safety and familiarity with the UCSD Undergraduate Chemistry Lab Rules.

A LAB SAFETY EXAM is given during the regularly scheduled lab periods within the first two weeks of class. A passing score on the quiz fulfills this requirement. Students who FAIL to demonstrate an understanding of general laboratory safety and familiarity with the UCSD Undergraduate Chemistry Lab Rules may be dropped from the course with a grade of "W."

This Study Guide is presented in response to the request of students. It must be considered a work in progress; we expect errors and omissions will be found and we hope to update & improving the Guide in coming terms. Please contact us with your corrections and suggestions, either for additional topics or for study questions.

This Guide can only be an introduction to the study of laboratory safety and hazardous materials management. We hope it gives students a chance to connect their chemical studies and lab exercises with an assessment of chemical & physical hazards and with the logic of recommended safety protocols. As safety professionals, we hope that our students will carry with them – to work and to home – a culture of safety and an ability to apply what they learn to the management and storage of hazardous materials in a variety of settings.

Study questions are provided after each section. It is hoped that these will provoke thoughtful responses, rather than rote memorization. If careful reading of the text doesn't supply a basis for a reasonable answer, please contact us for assistance (and to help us improve the Guide). Note that not all Safety Exam questions are included, although we've attempted to cover all pertinent topics. Group study is strongly suggested. Students who give each topic critical thought and suggest a reasonable answer to each question should be well prepared for the Safety Exam.

Versions. The original Study Guide was a pilot project for Summer 2003. The Study Guide is updated periodically, as needed. Please send suggestions and corrections to the Undergraduate Labs Safety Coordinator for inclusion in future versions.

Sheila Kennedy, CHO, Safety Coordinator
Undergraduate Teaching Labs
Department of Chemistry & Biochemistry
1110 Natural Sciences Bldg., Mail Code 0303
(858) 534–0221

John Palmer, PhD, Safety Director
Department of Chemistry & Biochemistry
2254 Urey Hall, Mail Code 0332
(858) 534-5906

STUDY GUIDE & PRACTICE QUESTIONS

1. LAB RULES & BASIC LAB PRACTICES

The **LAB RULES** for the Chemistry & Biochemistry Undergraduate Teaching Labs (the *Undergraduate Labs*) are posted in your lab (& included here). Study the Rules and **BASIC SKILLS** outline include here. Many of the practices recommended have been developed for safety – to protect lab workers from accidents and contamination. Others affect the precision and accuracy of the results you can obtain in your lab exercises. Some have implications for both safety & scientific accuracy. Some of these topics will be covered in more detail later.

Note particularly the rules concerning lab **clothing**. Appropriate clothing (*see* **PERSONAL PROTECTIVE EQUIPMENT (PPE)**) protects the body & feet from accidental contact with hazardous materials. Students who arrive unprepared or inappropriately dressed will be dismissed until ready to work.

BASIC LAB PRACTICES

Prudent practice. Review these guidelines frequently until these practices become habitual; many of our guidelines reflect practices common throughout labs in industry & the research community. In a situation not covered by these specific guidelines or the Lab Rules, the careful worker will asks "What would a prudent person do?" (i.e., what would be the careful and sensible thing to do?). Such prudent practice decisions save time, work and lives.

Housekeeping. Store backpacks and other extra materials away from work areas and off floors. Keep work areas clear, keeping only essential materials on the workbench.

Label all glassware and containers; use tape, a waterproof marker, or wax pencil. Clearly identify your chemicals as you work. Never touch hazardous chemicals with bare hands. Never remove chemicals from the laboratories. Do not attach samples to lab reports or notebook pages. In addition to causing disposal problems, taking samples out of the lab creates the potential for an accidental exposure.

Acid and base spills on inert surfaces (for spills on people, see **FIRST AID** and **SPILL RESPONSE**). Regardless of how small, spills must be THOROUGHLY CLEANED and NEUTRALIZED. Dilute acid with water and neutralize with solid sodium bicarbonate; use solid citric acid for base spills. After neutralizing the spill, rinse the surface with water. When the area appears to be clean, test the wet surface with pH test paper and repeat as needed to assure surfaces are neutral. Sodium bicarbonate and citric acid can be found in the lab Spill Kits.

Dispose of all used waste paper (towels, Kimwipes, etc.) in trash receptacles. Paper soaked with chemicals should be placed in solid hazardous waste containers, not in the general trash. If broken glass Is contaminated with hazardous or smelly materials, rinse with appropriate solvent before placing it in the broken glass box or jar.

Clean hood areas and benches at the end of each laboratory session. Check to be sure all reagents and waste containers are securely closed.

Avoid contamination of reagent bottles. Do not put spatula or other tools into reagent bottles. For a solid sample, pour an approximate amount onto a weighing paper or into a small container, then use a spatula to transfer what you need to the container on the balance pan.

A liquid chemical may have its own dispensing transfer pipette or syringe. Take care to keep the pipette with its own bottle. Do not put your own pipette into a reagent bottle. Pour the approximate amount needed into a graduated cylinder, then pipette the sample into your flask or beaker.

Never leave excess materials unattended or return them to the supply bottles. Try to make your excess available to another worker, then dispose of any remaining excess in the hazardous materials containers provided or in the non-hazardous trash, if appropriate.

Bottles, stoppers and caps. Chemical containers and waste bottles should be kept capped at all times between uses. After removing material from a container, replace the cap immediately, making sure to use the correct cap. Bottle caps and stoppers can contaminate a workbench or hood surface. Hold the cap while pouring – ask your TA to demonstrate this technique. If the bottle is too large, place the cap on a watch glass or weighing paper.

Anhydrous materials. Anhydrous materials (such as NaOH, $CaCl_2$, $MgSO_4$ or $NaSO_4$), absorb water from the air and MUST be kept tightly closed between uses. Left in the air, materials such as NaOH or KOH pellets will absorb moisture and produce a puddle of concentrated corrosive liquid.

Transferring liquids.

- Never return unused material to a reagent bottle.
- Never pipette by mouth.
- Use a funnel when transferring liquids.
- If an inorganic reagent spills down the outside of a bottle, cap the bottle hold it over a beaker; rinse the bottle thoroughly with water. For organics, rinse the outside of the bottle with acetone. Transfer the collected rinse solvent immediately to an appropriate waste bottle.
- Add a concentrated acid or base slowly to water with stirring; adding water to concentrated acids or bases causes local heating and splattering of the corrosive material.

Balances

- Do not place materials directly on balance pans. Choose weighing paper or a weigh boat, according to the size of the sample.
- Remember to calibrate and tare the balance – ask the TA for instruction.

- Clean the balance area after each use.
- Never leave any solid or liquid in or around the balance area. Use the brush to clear the balance area.

Waste disposal. Each lab exercise in the Undergraduate Labs has specific instructions as to proper waste handling and disposal. Unless you have specific instructions to "dispose to drains," assume all experimental wastes are hazardous and look for appropriate waste containers (see **WASTE MANAGEMENT**). Hazardous waste containers are provided when appropriate. On each of container is a clear description of the material(s) it should contain. Put waste materials in the PROPER container. There is a maximum fill line for each container. NEVER FILL THE BOTTLE ABOVE 90% of the container volume. Close a full bottle & leave it in its tray. Obtain a new waste bottle from the Stockroom (3150 York Hall or 1104 Natural Sciences Building).

Thermometers and glass tubing. When inserting a thermometer or glass tube into a rubber stopper, lubricate the glass with water, stopcock grease or glycerin and protect both hands with paper or cloth toweling. Grasp the thermometer/glass tubing near the stopper and push gently with a twisting motion.

Laboratory hoods. The vented laboratory hoods provided in all Teaching Labs are an integral part of the air handling system (see **ENGINEERING CONTROLS**). Hoods provide a safe work area for volatile hazardous materials. Air flows into the hood through the face and carries vapors and fumes out of the laboratory. Be sure to work in a hood when handling volatile materials that are toxic, corrosive, flammable or odorous.

LAB RULES & BASIC LAB PRACTICES Questions:

- What is the reason for prohibiting ALL food, drink, and smoking materials in the labs?
- Proper lab techniques often have both scientific and safety reasons. Which of the following items has both significant scientific *and* safety implications?
    1. *Wearing closed shoes and safety glasses*
    2. *Opening chemical bottles carefully and transferring chemicals without spills*
    3. *Noting numerical experimental results with appropriate significant figures*
    4. *Carefully reading names and other label information on chemical reagents used in experimental protocols*
- Why is the practice of using spatulas to scoop chemicals from bottles discouraged?
- Why is chewing gum not allowed in labs, even if you had it in your mouth when you arrived?

- What kind of work is best done only in a fume hood?
- Distinguish between "volatile" and "hazardous;" check a dictionary if unsure.

STUDY GUIDE & PRACTICE QUESTIONS

LABORATORY REGULATIONS
UCSD Undergraduate Teaching Laboratories

Prepare carefully. Attentive and considerate behavior is expected at all times. Maintain clean laboratory benches and common areas. Clean your own work area and any common areas assigned to you.

EATING, DRINKING, GUM CHEWING, AND SMOKING ARE FORBIDDEN in lab (to avoid chemical ingestion, excessive inhalation of harmful vapors, and ignition sources). Food, drinks, and smoking materials (including chewing tobacco) should be left outside the lab or stored in securely closed containers.

Prepare & Protect Yourself

The minimum level of safety protection necessary to work in the Undergraduate Teaching Labs is safety eyewear, closed shoes, and long (knee-length) lab coat. Students who arrive unprepared or inappropriately dressed will be dismissed until ready to work.

Safety Eye Protection: [Note: this is the Department rule; individual Instructors may use a more restrictive rule (*e.g.,* goggles only).] Safety Eye Protection must be worn by everyone at all times. All students, faculty, staff, and visitors are required to wear approved safety glasses or splash goggles, in addition to any prescription glasses.

Chemical splash goggles are required whenever anyone is transferring more than a small amount (~25 mL) of a hazardous material or when performing an operation involving a splash hazard. **Safety glasses** are designed for use in normal laboratory operations but offer only minimal splash protection.

Approved glasses and goggles are available at the UCSD Bookstore in the Price Center and the General Store Coop in the Student Center. With prescription glasses, choose goggles or safety glasses designed to fit over glasses. The Undergraduate Labs Stockrooms do not lend or sell goggles or glasses to students.

Additional eye and face protection (*e.g.,* full-face shields) are available and should be used as directed by the experimental procedure or the lab supervisor, or when the level of eye hazard is unknown. Always be sure to use proper eye protection when ultraviolet (UV) lamps or lasers are being used.

Contact lenses: The current understanding is that using contact lenses in lab creates no additional hazard. When worn with the safety eyewear required of everyone, contact lens wear is acceptable.

APPROPRIATE CLOTHING: Lab Coats and Closed Shoes are required in the labs. Choose sturdy shoes and a long style (knee-length) lab coat. Wear the coat closed to protect skin and clothing; make sure shirt sleeves don't protrude beyond coat sleeves. Avoid loose or very long clothing; remove loose jewelry; secure long hair and loose clothing away from flames, equipment, and chemical contamination.

GLOVES are provided in the labs and should be worn when working with hazardous chemicals. Ask the lab staff if you do not find suitable gloves stocked in your classroom. Remove gloves and wash hands before leaving the lab and entering public areas.

KNOW THE HAZARDS OF MATERIALS before you begin any procedure. Check the appropriate **Material Safety Data Sheet (MSDS);** additional information is available on bottle labels, in your laboratory manuals, textbooks, in the laboratories, in the Science & Engineering Library, and in the Undergraduate Chemistry Lab Stockrooms (YORK 3150 and NSB 1104).

KNOW YOUR SAFETY EQUIPMENT: In each lab, note exits & evacuation routes, presence/absence of installed telephone, location of first aid station(s), shower/eyewash stations, spill control materials & fire extinguishers. Know how to summon assistance from the Stockroom, Campus Police, or EH&S, as appropriate.

KNOW YOUR OWN LIMITS: If you have limited mobility or any condition that may limit your ability to work safely, consult with the lab staff, campus EH&S, and your health care provider. If you carry **medication** that might be needed on an emergency basis (*for example,* for diabetes or asthma), inform your lab supervisor or a responsible coworker. Work stations for **physically impaired or temporarily disabled students** are available; if you need these facilities, ask your Instructor. **Emergency Response Information Forms** allow students & staff to communicate medical information to Emergency Responders; blank forms are available in the lab Stockrooms.

STUDY GUIDE & PRACTICE QUESTIONS

Prevent Accidents
Horseplay and pranks are especially dangerous in a laboratory setting and are forbidden at all times. Keep all lab materials away from the **face & mouth**. Never pipet or start a siphon by mouth; this has been a source of serious laboratory mishaps. **Never work alone** in the laboratory and never perform unauthorized experiments. Students in the Undergraduate Labs must be attended by an Instructor, TA, or lab staff member.

HAZARDOUS MATERIALS HANDLING: Label all containers with contents (materials & concentration) and hazards. **Store** hazardous materials with earthquakes & other extreme conditions in mind. Use secondary containers (trays or tubs) and segregate materials according to hazard classes. Store hazardous materials **below eye level** and **return** all materials to their proper storage locations. Date containers when first opened.

Special secondary containers are provided for carrying hazardous materials outside the lab or between labs. To obtain a refill from the Stockroom, choose the appropriate secondary container to carry the empty bottle to the Stockroom. Request a refill and carry the filled container back to lab in the secondary container. Return the filled bottle and the carrier to the proper storage locations.

HAZARDOUS WASTE MANAGEMENT: Hazardous waste containers are provided; choose the correct container for chemical hazardous waste and for all broken glass (& other sharps). Unless explicitly instructed, do not dispose of any waste to the drains. Read labels and ask the TA, the Instructor, or the lab staff person for your course. The Environment, Health and Safety Specialist at the Undergraduate Labs (see below) or the lab safety staff at UCSD EH&S (x 43660) can also help you find information.

Use **fume hoods** for all work involving or producing flammable, corrosive, or fuming chemicals (*i.e.,* ammonium hydroxide or other strong acid and base). Any volatile toxic substance should be opened & used only in a hood.

Respond Appropriately to Accident, Emergency, or Sudden Illness
SUMMON ASSISTANCE and – if you are trained – **ADMINISTER FIRST AID.** Call the Undergraduate Lab Stockroom or send an uninjured person with a message – **TA must not leave students unattended in the classroom**. Emergency contact information is posted near each telephone (where available). If you suspect an ambulance will be needed, do not hesitate to call **9-1-1** (858-53**4 - HELP** from a cell phone) for assistance.

An **ACCIDENT REPORT** is necessary for **any accident or chemical spill**, no matter how minor the incident seems. These records are important in identifying recurring injuries, near misses, or problem areas.

PERSONAL EXPOSURE: If **clothing catches fire** or if a hazardous chemical is **spilled on skin or in eyes**, assist the exposed person to the shower/eyewash and rinse the areas of contact with copious amounts of water for 15 minutes or until assistance arrives; remove contaminated clothing. Call **9-1-1** or send an uninjured person to notify the lab staff to ensure injuries receive proper treatment.

Do not attempt **SPILL CLEANUP** without proper personal protective equipment (PPE). For large or very hazardous spills, call **9-1-1** for assistance. For **small spills,** use the spill cleanup kits and PPE provided; consult your lab supervisor and Material Safety Data Sheets for clean up precautions. Double bag and label contaminated materials; store in the Hazardous Waste Area of the lab. Notify the lab staff – disposal will be arranged.

For a **mercury (Hg)** spill use **only** the mercury collectors provided in the spill kits. Do not mix mercury with any other waste. There are no waste handlers who will accept such mixed waste.

BUILDING EVACUATION: In any situation, assure the safety of people before considering any damage to property. When instructed, leave the lab immediately. **Use stairs, never elevators** (power may fail in an emergency). **Pull the fire alarm** as you exit; as soon as you reach a safe location, call **9-1-1** (858-53**4 - HELP** from a cell phone) and report the situation to the UCSD police. Go to the assigned assembly location for your lab. The lab supervisor will take attendance (to assure everyone is safe) and provide this information to responding emergency personnel. Do not leave the area or reenter buildings until instructed to do so. Note any injuries to yourself or others and any remaining dangers. Provide assistance to injured persons, as long as you do not place yourself in additional danger.

FIRE: Do not attempt to fight fires in the lab (except on clothing – use shower/eyewash); evacuate the lab quickly (see **Building Evacuation**); close all doors and call for assistance. Fire extinguishers are placed in the labs for use on small fires by trained personnel working in pairs.

EARTHQUAKE: move away from overhead lights, heavy unsecured objects, and hazardous materials. Choose a sheltered position to wait (under a table, in a door frame, or against a bearing wall). Once the tremor stops, shut down gas lines & heat sources. Exit the building quickly (see **Building Evacuation**).

2. EMERGENCY & DISASTER RESPONSE

An appropriate response to any emergency situation always considers ***people before property.*** It is the responsibility of each lab worker (student, staff, TA or instructor) to know his/her role in an emergency and to respond appropriately, always safeguarding lives and the safety of people first.

Begin by studying the **emergency equipment** provided in the Teaching Lab (and in each new lab you enter). Learn the locations of the exit doors, telephones, shower/eyewash, the first aid & spill kits, fire extinguishers & fire blanket. Learn when to use these item (*see* **FIRST AID** and **FIRE SAFETY**).

Many emergencies can be prevented. **Dispose** of broken glass and other hazardous items, such as corrosive liquids or flammable products (*see* **WASTE MANAGEMENT**) so these items do not cause injury. Dispose of all nonhazardous rubbish in the trash cans and keep floors clear & dry at all times to prevent accidents. Each lab is provided with a storage area for backpacks & other personal items away from work areas and off lab floors. Careful storage protects workers from tripping and protects books and other materials from spills.

An **emergency**, such as an injury or sudden illness, requires quick response with appropriate **FIRST AID** measures by those nearest. Communicate quickly with the lab staff so they can assist the injured or ill person and call for needed assistance.

You may have information that should be communicated to an Emergency Responder (paramedics or emergency room staff) in case of accident or injury in which you are not able to respond. This information (allergies, medications, *etc.*) can be recorded on an **EMERGENCY RESPONSE INFORMATION** form. The lab staff strongly encourages everyone to complete this form and make it available by securing it inside the back cover of the student lab notebook. Carry a copy in your wallet or backpack. If needed, the information will be passed only to Emergency Responders. Anyone carrying **emergency medication** should make the lab supervisor or another student aware of its location so they can assist, if needed.

A **disaster**, such as a major chemical spill, a fire or an earthquake, may require **building evacuation.** Learn your building's assembly location (see below) and the evacuation route from your lab. Assembly locations are chosen to allow groups to gather away from buildings, clear of Emergency Responders' operations, and away from overhanging power lines and tree branches. Your assembly location may be moved to allow Emergency Responders (Police, Fire Fighters, Paramedics) to work. Follow all instructions of Emergency Responders.

The Undergraduate Labs does not conduct fire drills. When you hear an alarm, assume it is real; quickly turn off any open flames or electrical equipment in your area. Exit the building quickly, using *only the stairs* – remember that elevators depend on electric power and may fail. If you can, assist anyone who has difficulty with stairs. If you can't help, tell lab staff or emergency responders *what* help is needed and *where* the person is located.

STUDY GUIDE & PRACTICE QUESTIONS

Gather your group at the **assembly location**; your TA or instructor will take roll to assure that everyone is safely evacuated – be sure you are counted. Notify a staff member or emergency responder if anyone is missing. A complete accounting is essential, as Emergency Responders will search for missing persons.

Report any information you have about damage to the building or about the situation in the building (location of the fire, *etc.*). Do not leave the area or renter the building without explicit instructions.

Earthquake is a special case of building evacuation, as it is better to *wait until the shaking stops*. Take a position near a strong wall and away from windows or other glass that may shatter; keep your body low and protect your face. Be aware that light fixtures may swing loose and watch for unsecured equipment that may be shaken off a table or bench. When the first shaking stops, evacuate as for a fire, paying special attention to reporting damage and unsafe conditions.

EMERGENCY AND DISASTER RESPONSE Questions:

- What is an **EMERGENCY RESPONSE INFORMATION** form and who should use one?
- Suppose you carry emergency medication that may be needed on short notice. What are the *pros* and *cons* of informing others (roommates, lab partner or lab supervisor) of its use & location?
- How does building evacuation for an earthquake differ from evacuation for a building fire?
- How often does the Chemistry Department run fire drills in the Teaching Labs?
- Where does your class assemble in an evacuation? Why?

STUDY GUIDE & PRACTICE QUESTIONS

EMERGENCY RESPONSE INFORMATION

Students & staff may, at their own discretion, provide information to assist responders in case of emergencies; revised/replaced as needed.
Students: Tape this form INSIDE THE BACK COVER OF THE LAB NOTEBOOK. Staff: carry in wallet/backpack.
If you are ill/injured and cannot respond, this information will be provided to emergency responders (paramedics/hospital personnel).

NAME _____

ADDRESS _____

_____

PHONE _____

DATE OF BIRTH _____

UCSD ID # _____

EMERGENCY CONTACT (*i.e.*, a responsible person who should be notified if you are ill/injured)

NAME _____

Address _____

_____

Phone _____

Relationship _____

MEDICAL INFORMATION

(List ALL allergies (food, medication, plants, bites, etc.), ongoing medical concerns, and history of serious illness/seizures/fainting.)

_____

_____

_____

_____

DO YOU WEAR CONTACT LENSES? (important in case of eye injury) Yes __ No __

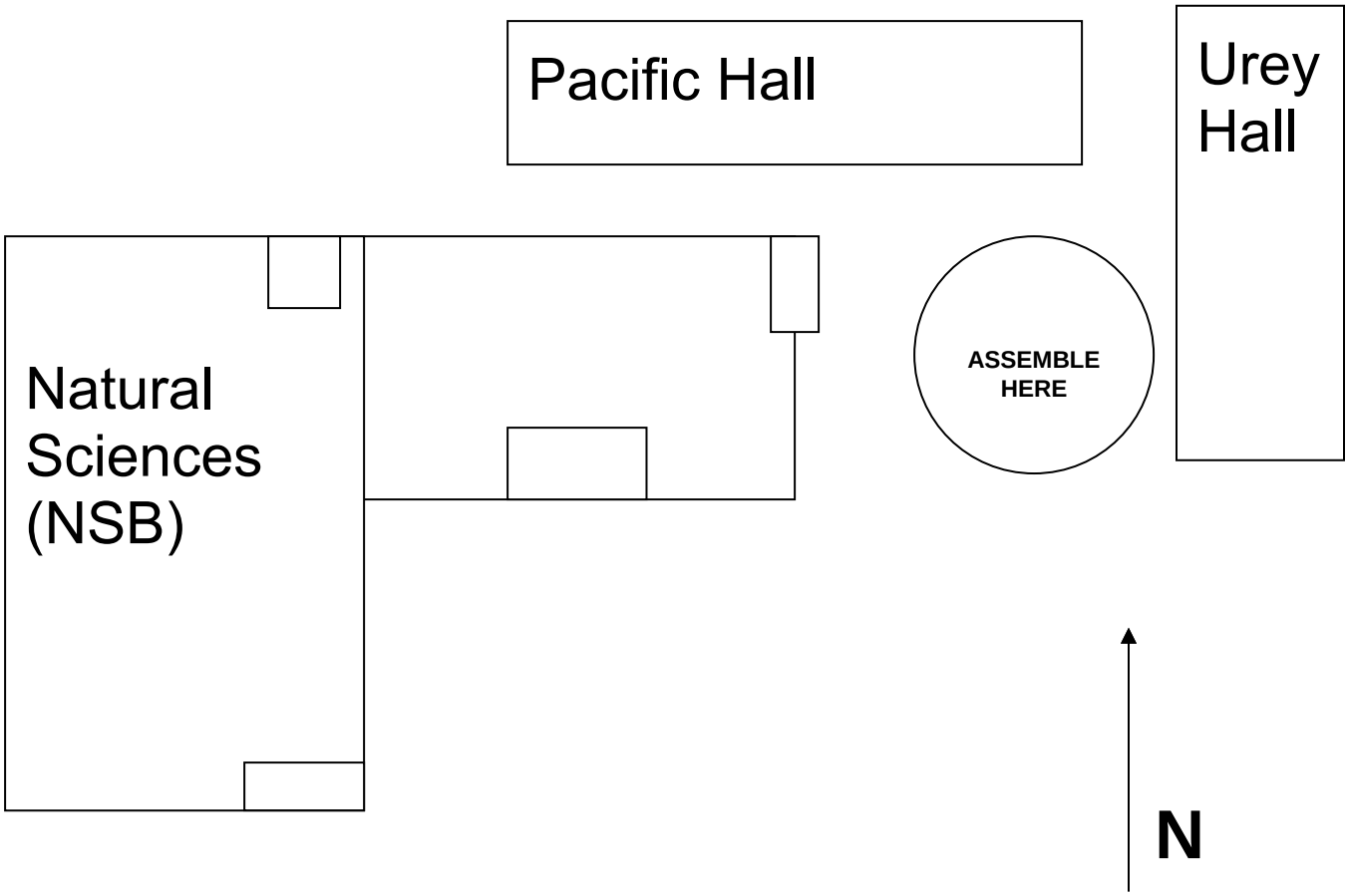
CURRENT MEDICATIONS (Copy information from medication labels for **all** medicines – prescription & over-the-counter.)

Name of medication	Dose	Frequency
example: *tetracycline*	*250 mg*	*twice/day*
Sudafed	*200-400 mg*	*as needed for sinusitus headache*
_____	_____	_____
_____	_____	_____
_____	_____	_____

Emergency Response Information forms are available in Teaching Labs and in the Labs Stockrooms.

STUDY GUIDE & PRACTICE QUESTIONS

BUILDING EVACUATION
Natural Science Building



Shut down open flames & electrical equipment in your work area.

Close doors as you leave.

Use stairs only – elevators may fail.

Assist others where possible – report injuries to Emergency Responders.

<u>Assemble your group between Pacific Hall, NSB and Urey Hall</u> – keep all driveways clear.

Take roll & report missing persons to Emergency Responders.

Follow instructions of Emergency Responders.

Return to building only on instructions of

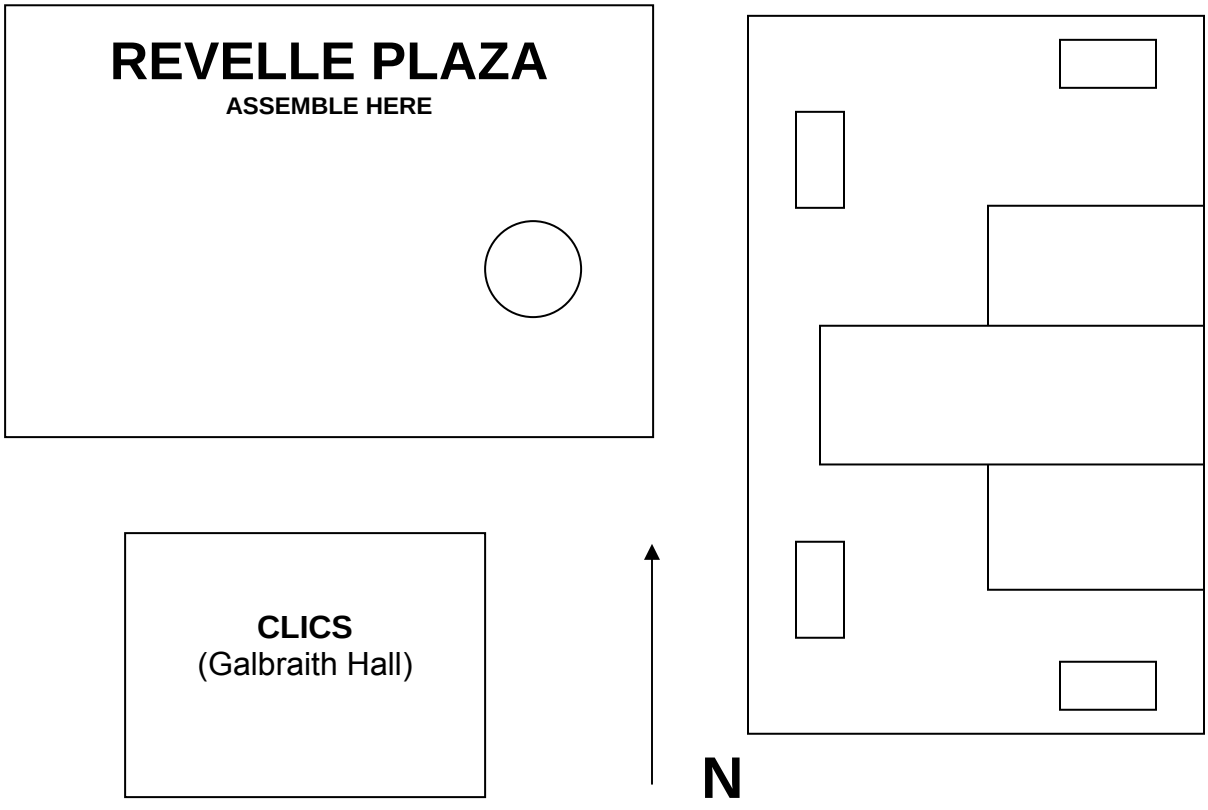
Emergency Responders

EH&S Staff

Lab Staff.

STUDY GUIDE & PRACTICE QUESTIONS

BUILDING EVACUATION
York Hall



Shut down open flames & electrical equipment in your work area.

Close doors as you leave.

Use stairs only – elevators may fail.

Assist others where possible – report injuries to Emergency Responders.

<u>Gather your group in Revelle Plaza</u> – take roll & report missing persons to Emergency Responders.

Follow instructions of Emergency responders.

Return to building only on instructions of

Emergency Responders

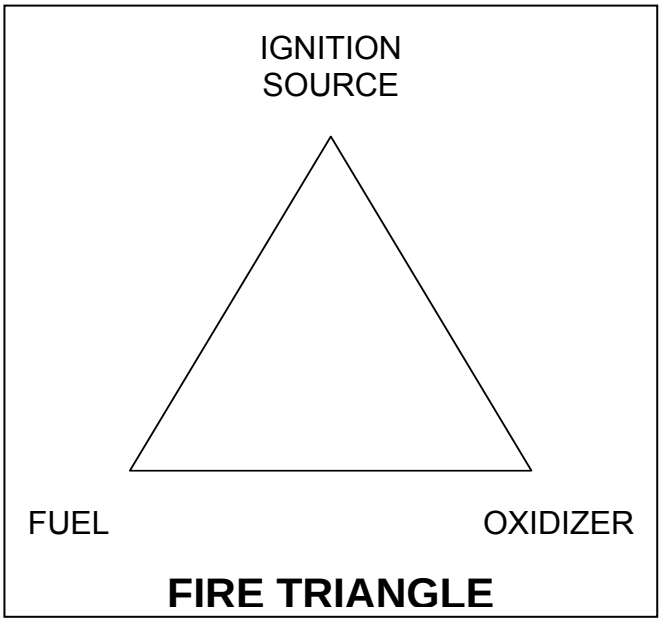
EH&S staff

Lab Staff.

3. FIRE SAFETY

A. FIRE PREVENTION

Fire Triangle*: Three things are necessary for a fire: a fuel, an oxidant and a heat or ignition source. If any one of these is missing, a fire will die or fail to ignite. Understanding this gives you a way to think about how a fire will progress. In an "ordinary" fire, the fuel might be wood, the oxidant oxygen from the surrounding air, and the ignition source might be a match. In the lab, the fire might consist of natural gas, ambient oxygen and a spark from a flint lighter, or the vapor from an open beaker of ether plus ambient air and the heat from a hot plate. In any of these situations, the fire can be stopped (or prevented) by keeping the fuel (wood, gas, or ether) away from the heat/ignition source (match, spark, hot plate). In the last case, the flammable solvent should not have been used in the same area as a hot plate.



FIRE TRIANGLE

An open flame is a useful lab tool and has many applications, if it is kept under control. Keep flammable materials that are not intended to be part of a reaction – including gas hoses, sleeves, books & hair – away from the burner flame and away from materials such as tripods and ring stands that have been heated by the flame. Keep containers of flammable materials closed except when in use. If many flammable materials are present, set aside a limited area of the lab for open flames and keep all flammable materials away from that area.

Anticipate working with open heat sources when preparing for lab. Choose flame retardant natural fibers, such as cotton, wool and linen, for lab clothing. Synthetics fibers, such as nylon, tend to burn easily or melt onto skin and are particularly inappropriate for lab wear.

In lab, remove loose jewelry and remove or restrain very long or loose clothing. Manage long hair to prevent loss or contamination. These items can catch fire or contact hazardous chemicals. Synthetic (acrylic) fingernails have been tested for flammability and are surprisingly flammable and, once ignited, very difficult to extinguish.

---

*A more complete statement involves a reaction mechanism as a fourth necessary condition. The image then becomes a “fire tetrahedron.” The rest of the discussion remains the same.

STUDY GUIDE & PRACTICE QUESTIONS

B. FIRE RESPONSE

An appropriate response to a lab fire or other accident always involves consideration of ***people before property.*** A student's first response should be evacuation of the area, assisting others where possible, followed by notification of those who can assist: lab staff, fire department, *etc*. (see **EMERGENCY & DISASTER RESPONSE** for building evacuation). Once students are safe, persons trained in the use of fire extinguishers can then consider using extinguishers.

Clothing or hair on fire is a serious emergency that requires immediate response from the nearest unaffected person, as the victim will be unlikely to remember previous training. Use any means at hand to prevent the victim from running, as running feeds the flames and make the fire worse. Smother the fire with any item available (coats, blankets, jackets, sweatshirts, *etc*.). **Fire blankets** are provided in the labs for this purpose, but the nearest available item should be used to respond without delay.

Fire extinguishers are placed in the labs to be used by **trained** personnel – always working **in pairs, never alone**. Lab TAs are trained in the use of fire extinguishers, as are some of the lab assistants. It is not expected that undergraduate students have been trained & they are not expected or encouraged to use fire extinguishers. Students should learn **about** extinguishers as part of basic safety training and take advantage of any opportunity to be trained in their use.

Each fire extinguishers is designated (**A, B, C,** *etc*.) according to the type of fire it is designed to extinguish. Learn the mnemonic for each to help you remember the types:

EXTINGUISHER CLASS:	for fires involving:
Class A (**A***sh*)	ordinary combustible materials (*e.g.,* trash, wood or paper)
Class B (**B***urning liquids*)	burning liquids (*e.g.,* organic solvents, gas, paint)
Class C (**C***urrent*)	energized electrical equipment

Other classes exist, but these are the ones of concern in our introductory courses. An **ABC** combination extinguisher can be used on any or all of these fires. It contains a dry chemical powder. The **class B** extinguishers provided in the organic chemistry labs contain carbon dioxide (CO_2) under pressure.

STUDY GUIDE & PRACTICE QUESTIONS

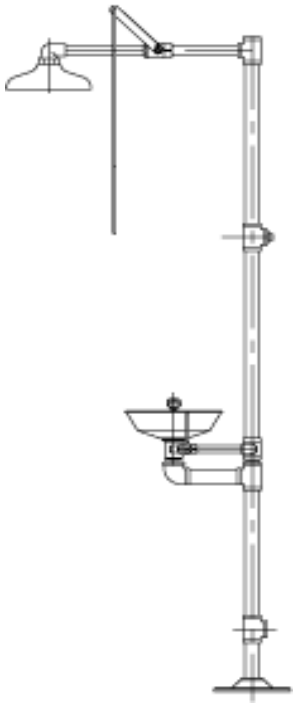
FIRE SAFETY Questions:

- What should you do if you observe a fire in an unattended hood in the lab?
- What would be the effect of covering a beaker of burning acetone with a watch glass?
- What kind(s) of fire extinguishers are supplied in your lab?
- How many of each kind?
- For what kind of fire is each intended?
- Which of those fire extinguishers would a trained worker choose to extinguish a paper fire (*for example,* a research notebook, containing all the lab notes for a long-term research project)?
- What kind of fire extinguisher would be chosen to extinguish a fire involving an organic solvent (*e.g.,* ethanol or acetone)?

4. FIRST AID

In the event of accident or sudden illness, the nearest persons on the scene should render assistance whenever it is possible to do so without increasing the danger to others. Everyone should take an opportunity to be trained in at least Basic First Aid. Classes are offered through various community organizations, through the University, and by the American Red Cross.

You may have information that should be communicated to an Emergency Responder (paramedics or emergency room staff) if you are involved in an accident or injury and are not able to respond. This information (allergies, medications, *etc.*) can be recorded on an **EMERGENCY RESPONSE INFORMATION** form (*see* **EMERGENCY AND DISASTER RESPONSE**). The lab staff strongly encourages everyone to complete this form and make it available by securing it inside the back cover of the student lab notebook or carrying it in wallet or backpack. If needed, the information will be passed only to Emergency Responders. Anyone carrying **emergency medication** should make the lab supervisor aware of its location so that aid can be given if needed.



Uninjured persons are the first responders and must take responsibility in an emergency situation, as the injured person will not remember previous training or will be unable to follow it. Others must begin rinsing spills or rendering aid as soon as possible, as time *before aid* is critical in minimizing injuries. Keep area clear for TA and Emergency Responders to work; provide privacy and extra clothing as needed. If emergency shower is in use, move people who are not helping outside, as floors will be slippery. Remain alert for instructions from the TA and give assistance where possible.

Hazardous chemical spill – on skin or in eye. Begin rinsing affected area immediately with water only – no soap or scrubbing; continue rinsing for *15 minutes*. If serious injury is suspected, continue rinsing until paramedics arrive on the scene and begin medical evaluation. An uninjured person must keep time. Use eyewash for face: begin rinsing with goggles on, then remove goggles and continue rinsing. Gently hold eyes open with fingers. Use emergency shower for body and remove contaminated/shoes while rinsing. Clear the area of other persons. If your assistance isn't needed at the moment, wait outside the classroom; give further assistance if needed. Call for

assistance **(9-1-1)** & notify lab staff. Seek medical assistance and give all information (including the nature and concentration of the spilled material and any **EMERGENCY RESPONSE INFORMATION** form, if available) to Emergency Responders. Complete an Accident Report.

Sudden Major Illness. Major illness may include

- serious cuts or burns,
- difficulty breathing,
- seizure,
- loss of consciousness,
- *any* head wound.

CALL 9-1-1 WITHOUT DELAY. First responders on the scene (student, TA, Instructor or staff) should call for assistance, prevent further injury/contamination, apply pressure to stop bleeding and, if trained to do so, begin CPR where needed. Identify possible chemical contamination or exposure and give information to Emergency Responders.

Fire blankets are provided. Use the blanket to cover a person who is ill or injured to keep them warm & prevent shock.

Call for assistance **(9-1-1)** & notify lab staff. Seek medical assistance and give all information (including **EMERGENCY RESPONSE INFORMATION** form, if available) to Emergency Responders (paramedics/emergency room staff). Complete an Accident Report.

Minor Injuries: burns & cuts. Notify TA without delay, even for the most minor injuries. Identify possible chemical contamination/exposure and seek First Aid. Rinse burns and chemical contamination with cool running water for 15 minutes – no soap or scrubbing. Wash cuts gently; apply pressure to stop bleeding; use bandages in first aid kits. Notify lab staff if assistance is needed. Consider medical assistance and give all information (including **EMERGENCY RESPONSE INFORMATION** form, if available) to Emergency Responders (paramedics/emergency room staff). Complete an Accident Report.

FIRST AID Questions:

- If you get a chemical splashed in your eye(s), you should flush your eye(s) with running water for at least how many minutes?
- Where is the First Aid kit in your lab stored?
- Where is the fire blanket?
- What might be your role in an emergency response if you were the nearest uninjured person? If you are at the other end of the room?

- Who should be notified in case of a sudden illness or injury in the lab?

STUDY GUIDE & PRACTICE QUESTIONS

5. HAZARDOUS MATERIALS

A substance is called a *hazardous chemical* if it has one or more of the following characteristics:

- Toxic
- Reactive (including radioactive)
- Flammable/Ignitable
- Corrosive

In addition, it may be a *hazardous material* if it presents physical or electrical hazards (sharp edges, extreme temperature, or high voltage, for example).

Remember that a ***hazard*** is an inherent property of the material and not generally something that can be changed. The associated ***risk*** of working with a hazardous material is a combination of the inherent hazard and the degree to which a worker is exposed. Understand the hazard, then minimize the risk by minimizing exposure.

Hazardous materials are found in nearly all workplaces and in most homes. The hazards inherent in the materials do not change with location or intended use. Check your garage and cleaning supplies for labels that warn (often in very small lettering) "wear gloves" or "use only with adequate ventilation." These materials (from razor blades to concentrated acids) should always be handled with care and disposed of properly, whether found in a chemistry lab, a manufacturing shop, or a home cleaning or hobby cupboard.

A. HAZARD IDENTIFICATION

Hazardous Chemicals, *TRICKY* Materials. Hazardous chemicals fall into one or more of the following groups. Remember that these are **TRIC**ky materials (**T**oxic, **R**eactive, **I**gnitable, **C**orrosive) and one material may fall into any combination of these groups. Characteristics which are useful in controlled chemical reactions may become injurious if allowed to proceed in contact with living tissues or if the reaction proceeds more quickly than desired. Thus, a reaction of a base with a fat – used commercially to form a soap – may cause a deep penetrating chemical burn if the fat involved is in your skin or eye. In another case, a useful oxidation reaction may proceed slowly under controlled conditions or explosively when uncontrolled.

Toxic materials cause poisoning or illness through a wide variety of routes. Toxicity is a difficult hazard to quantify and predict. *Carcinogens* (materials that cause cancer) are a special group of toxic substances, as are *mutagens* and *teratogens*. *Irritants* cause transient effects which may be mild or serious; *allergens* may cause reactions in people who have become sensitized through previous exposure. *Asphyxiants* interfere with the supply of oxygen to vital organs; a *chemical asphyxiant* ties up oxygen; a *simple asphyxiant* (such as CO_2) displaces oxygen.

Reactive materials are those likely to react spontaneously under normal conditions; uncontrolled reactions may cause explosions or start fires. These may include *oxidizers* (such as nitrates, $-NO_3$) or strong *reducers* (such as hydrazine, NH_2NH_2), as well as those that react spontaneously with water or air. Other materials are stable in themselves, but must be kept apart from materials with which they would react strongly (*incompatible* materials); careful storage of hazardous materials keeps incompatible materials separated. Thus, acids and bases are stored in such a way that they would not mix, even if the bottles were broken. *Radioactive* materials are a special case of reactive materials. Radioactive materials emit ionizing radiation as unstable atomic nuclei decay to form more stable nuclei; the emitted radiation (which may occur in several forms) may damage living tissues or effect changes in nearby materials. Ionizing radiation may also be emitted by machines such as X-ray machines. We do not currently use any radioactive materials in the Undergraduate Labs; any workplace in which you will use such materials will be required to provide training in the appropriate use & precautions.

Flammable (ignitable) materials are those that readily ignite & burn in air (***see also***: Fire Triangle, section 3); many common solvents are highly flammable and require special care.

Corrosives are materials (solids, liquids or gases) that cause corrosion on metals or 'eat away' living tissues. These may be acids (such as hydrochloric acid, HCl, or sulfuric acid, H_2SO_4) or bases (such as sodium hydroxide, NaOH, or ammonium hydroxide, NH_4OH).

Physical/mechanical hazards are common in labs and many other workplaces. Injuries from slipping, tripping, falling, crushing and cutting are among the most common workplace hazards. Read and understand the instructions for any machine before using it. Keep walkways clear and keep floors dry. Remain alert to *sharps* – any item that could cut through a plastic trash bag, including razor blades, needles, fine pipettes, and any broken glass. Careful disposal of sharps in the special containers provided in the labs protects lab workers as well as others who may enter the lab.

Thermal hazards arise when materials are substantially hotter or colder than normal room temperatures. Use tongs, insulated gloves or other aids to guard hands and other skin surfaces from contact with extreme temperatures. Remember that hot glass looks just like cool glass; hold a hand *near* a suspect item to feel heat radiating from the surface. Set hot glass in a labeled area or in a second container while cooling. Use similar precautions when working with very cold (cryogenic) materials, such a liquid nitrogen or dry ice ($CO_{2(s)}$).

The risk of **electrical shock** arises when current runs in unplanned ways. This may result from worn, damaged or improperly grounded instruments. Read and understand the instructions for any machine before using it; check all electrical cords and replace worn ones immediately. Manage cords to reduce mechanical wear and restrain excess lengths (preventing trip hazards, as well). Do not overload circuits or operate instruments on extension cords.

B. HAZARD ASSESSMENT

Some indices help us to assess the level of hazard present in a particular material.
Toxic materials cause poisoning or illness. As simple as that statement seems, it's difficult to quantify or predict toxicity. Much of what we know about human toxicity has been learned from the investigation of environmental contamination (such as mercury poisoning, called *Minimata disease*) or industrial exposures (such as *asbestosis* in asbestos miners or *black lung disease* in coal miners). In such situations, it's often difficult or impossible to determine the *threshold limit* (the concentration at which an effect is first observed).

Other data can be gathered by testing materials on such species as fish, mice or rats, observing effects with increasing doses, generally with large populations. The dose at which half of a population of mice dies of an ingested toxin is called the $LD_{50,\ mouse,\ ingestion}$ (= lethal dose for 50%, species and route of exposure) and will be expressed in units of mass of toxin (mg or µg) per unit of body mass (g or kg). Similarly, a toxic dose (or concentration) for 50% of a population is expressed as TD_{50} (TC_{50}). From this kind of data, we can observe that one material is substantially more toxic than another (has a *smaller* LD_{50}) in mice (and should therefore be handled appropriately by those caring for mice), but we can't tell anything directly about the toxicity of either material in humans. We may, however, decide to be very careful with a material which is toxic in fish, mice and rats, treating it as though it were toxic to humans as well.

Flammable materials. The *flash point* of a material is the temperature at which the liquid has sufficient vapor pressure to form an ignitable mixture in air near the liquid surface; many common materials have flash points below common room temperatures. In addition, each material has upper & lower *flammable limits*. For example, acetone (a common and useful laboratory solvent) has a flash point of -18C and lower & upper flammability limits of 2.6% and 12.8% in air; if a room temperature spill of acetone produced a mixture of 10% acetone in air in the immediate area of the spill, an extreme fire hazard would exist until the acetone was cleaned to less than 2.6% in air. Until that time, any spark or other ignition source might ignite the flammable mixture, causing a fire which might spread to other materials.
The *ignition temperature* (or *autoignition temperature*) is the point at which the substance (liquid, solid, or gas) has enough energy to initiate self-sustained combustion, independent of the heat source. No spark is necessary for ignition when a material reached its ignition temperature: diethyl ether ($H_5C_2OC_2H_5$) has an ignition temperature of 160C and can be ignited (liquid or vapor) on the surface of a laboratory hot plate; carbon disulfide (CS_2) has an ignition temperature of 95C and can be ignited by a glowing light bulb.

Corrosivity is assessed by testing the pH of a solution (or a solution made from the dry material); dip a clean glass rod into the solution and touch the drop adhering to the rod to a pH test paper. A neutral solution has a pH of 7; a lower pH indicates an acid solution; a high pH (up to 14) indicates a basic (alkaline) solution. The more extreme the pH value, the stronger the acid or base. (*Strong* is not the same as *concentrated*; review any general chemistry text.)

STUDY GUIDE & PRACTICE QUESTIONS

HMIG (**H**azardous **M**aterials **I**dentification **G**uide) ratings are shown on many chemicals in the labs, including unknown samples prepared for analysis by students. This rating, along with other information sources (*see* **HAZARD COMMUNICATION**) can help you evaluate the hazards of the materials you work with. This system indicates the level of hazard for Health, Flammability, & Reactivity as well as the appropriate Personal Protective Equipment (PPE). In each category, 0 = minimal, 1 = slight, 2 = moderate, 3 = serious and 4 = extreme hazard. For example: a bottle may be marked

HMIG 1 – 2 – 0 – C

indicating that the health hazard (including considerations of toxicity, corrosivity, and other health effects) is slight; the flammability hazard is moderate (requires moderate heating to ignite; flash point 100 – 200°F); the reactivity hazard is minimal (normally stable & does not react with water); a PPE rating of C is a recommendation for the use of goggles, gloves and an apron (or lab coat). Posters in the labs show the details of this labeling system.

C. HANDLING & STORAGE

Refills of hazardous chemicals. If refills are needed during a lab session, proceed with caution: close the empty container and rinse the outside of the bottle to remove any contamination. Choose an appropriate secondary container and use it to carry the empty bottle to the Stockroom Service Window attendant (in 3150 York Hall or 1104 NSB). Two secondary containers are provided in each lab – a larger red bottle carrier (for bottles ~0.5 to 2.5 liters) and a covered tub for smaller bottles. If your bottle is very small, set it in a beaker inside the covered tub to prevent tipping & spilling. Request a refill at the Stockroom and carry the refilled container back to your lab in the secondary container. Return the bottle and the carrier to their proper storage locations.

Hazardous materials storage plans reflect our understanding that various chemical classes will react with each other, given the chance. Reduce the chance of unintended reactions by storing bottles in secondary containers (trays or tubs that will contain spills) and storing *incompatible* items (acids & bases *or* oxidizers & fuels) separately. Earthquake strips on shelf edges keep things from falling during a tremor. Bottle caps and cupboard doors should be closed whenever not in use. Flammable materials, which might become involved in a fire, are stored in closed cabinets, except in small quantities needed in the labs. Observe and respect the *No Storage* labels in certain areas in the labs; these areas are either not earthquake safe or materials stored there might interfere with fire sprinklers or other essential systems.

STUDY GUIDE & PRACTICE QUESTIONS

Hazardous materials handling.

- Open & close bottles with care, guarding against spills.
- Hold a cap or lid in your hand while pouring or set it on a clean watch glass; this guards against contamination of the benchtop and the reagent.
- Clean (and report) all spills immediately (*see* **BASIC LAB PRACTICES** and **SPILL RESPONSE**).
- Obey signs about designated areas for particular activities, such as flame tests.
- Dispense liquids from beakers or bottles by holding a clean glass rod to the rim of the pouring container and pouring the liquid down the rod. This takes a bit of practice but it allows you to direct the flow of liquid into the receiving vessel. Practice with a small beaker and water.
- When your procedure generates a hazardous waste, collection the waste in a beaker, rinsing your glassware with an appropriate solvent. Any glassware or stir bars that fall into your beaker can be retrieved before you transfer your waste to the appropriate waste bottle.

HAZARDOUS MATERIALS Questions:

- How do you know when a material is *hazardous*?

- In an earthquake, all bottles in a storage container may break and mix. Which of the following is an unsafe group to store together (*hint:* think about what class of chemical each belongs to)?

  1. hydrochloric acid, sulfuric acid, phosphoric acid
  2. acetone, ethanol, benzene
  3. ammonium nitrate, machine oil, and potassium permanganate
  4. sodium chloride, calcium sulfate, potassium phosphate
  5. tetrahydrocannabinol, opium, sodium barbiturate

- **for o-chem students:** What class of chemicals forms shock-sensitive, explosive peroxides (R-O-O-R) upon air exposure and long-term (months to years) storage?

  1. organic ethers (R-O-R)
  2. inorganic oxides
  3. permanganates
  4. sulfites
  5. saturated organic hydrocarbons (C_xH_{2x+2})

- Which of the following factors affects our choices in storing hazardous materials?

  1. Chemical compatibility
  2. Safety of workers who will handle containers later
  3. Earthquake safety
  4. Convenience
  5. Regulatory mandate

STUDY GUIDE & PRACTICE QUESTIONS

- How would you carry an empty 1.5L bottle to the Stockroom in order request a refill of 1*M* NaOH solution? Assume NaOH (sodium hydroxide) meets at least one of the criteria for being *hazardous*.
- Why are you instructed to transfer methylene chloride only in the fume hood? (Hint: good reasons would include flammability, toxicity, liquid spills, volatility; check the MSDS for methylene chloride (CH_2Cl_2).
- Suggest a rule that might be used to prevent tripping on backpacks in a crowded lab.
- What is the best way to warn others working around you about the hazards of YOUR materials?
- Describe a safe method for heating materials over an open flame, such as a Bunsen burner.
- Can you see the difference between hot and room-temperature glass?
- Suggest a useful strategy for handling broken or chipped glassware.
- Which of the following chemicals is most likely to cause a penetrating burn, but little initial pain upon exposure to your skin? Which will cause immediate pain and burning? Which is a significant fire hazard? Choose any that apply.
    1. sulfuric acid (H_2SO_4)
    2. sodium hydroxide (NaOH) pellets
    3. silver nitrate ($AgNO_3$)
    4. ethanol (CH_3COOH)
    5. acetyl chloride (CH_3COCl)
- Which of the following materials should ONLY be used in a laboratory fume hood? Why?
    1. Ether
    2. Methylene Chloride
    3. Hydrogen Sulfide
- The **HMIG** (Hazardous Materials Identification Guide) rating on many chemicals in the lab, including unknown samples, indicates the level of hazard for Health, Flammability, & Reactivity as well as the appropriate Personal Protective Equipment (*e.g.*, 1 – 2 – 0 – C). 0 is the lowest and 4 is the highest rating. If a liquid material is rated '4' for *flammability*, how might this tend to affect your *health related* exposure?
- A common injury in the Undergraduate Labs is a hand cut from the sharp (narrow) end of a Pasteur pipettes. Describe a storage strategy to avoid such injuries.

STUDY GUIDE & PRACTICE QUESTIONS

6. HAZARD COMMUNICATION

Clear communication of hazard information allows workers to make informed decisions about the work they plan to do and the materials with which they will work. Sources for such information include bottle labels (manufacturer's and our own), lab signs, reference books, catalogs, and Material Safety Data Sheets (MSDS).

Material Safety Data Sheets (MSDS). In the United States, manufacturers are required to supply MSDS when shipping hazardous materials in interstate commerce. Employers are required to keep MSDS available to their employees who work with hazardous materials. In other jurisdictions, such as Canada & the European Union, similar rules apply. *Safety data sheets* are available in various formats on the internet.

Students in the Teaching Labs are not employees (although the TAs are) and no similar regulation currently constrains the University to make such MSDS available to students. Prudent practice, however, suggests that everyone working in an area should work with similar expectations and standards; it is also expected that students will enter into workplaces where these regulations apply fully. MSDS are therefore made available to students on the same basis as to employees (instructors, TAs & staff).

Locate an MSDS:

- on the University of California MSDS site (*http://www.ucmsds.com*); if requested, log in as ***ucsd_user*** and use the password ***ucsd***
- on the UCSD Environment, Health & Safety site: *http://ehs.ucsd.edu*
- on the Science & Engineering Library site: *http://scilib.ucsd.edu/corechem/freechem.html*
- paper copies in the Undergraduate Labs Stockroom (3150 York Hall or 1104 NSB)
- selected collections in specific labs for the materials expected to be used in that lab

Further information on using MSDS is available at *http://ehs.ucsd.edu*.

MSDS are organized according to a set pattern, although a variety of formats will be seen. You can expect to find the following information:

1. **Identity** of the material, including its chemical and common names. *For example*:
   brand name: Clorox$_{(TM)}$;
   chemical name: sodium hypochlorite;
   common name: bleach.
2. **Hazardous ingredients** (in parts as small as 0.1%).
3. List of **physical & chemical hazards and characteristics**
   (unstable, reactive, flammable, explosive, corrosive, *etc*.).

4. List of **health hazards**, including:
   Acute effects, such as burns or unconsciousness, that may occur immediately.
   Chronic effects (such as allergic sensitization, skin problems, or respiratory disease) that may appear over a period of time or after long exposure.
5. If the material is listed as a **carcinogen** by the US Occupational, Safety & Health Administration (OSHA), the International Agency for Research on Cancer (IARC), or the National Toxicology Program (NTP).
6. **Exposure limits, primary routes of entry** into the body, specific **target organs** likely to sustain damage, **medical problems** that can be aggravated by exposure.
7. Precautions and safety equipment.
8. Emergency and first aid procedures.
9. Specific fire fighting information.
10. Procedures for cleanup of spills and leaks.
11. Precautions for safe handling and use, including personal hygiene.
12. Identity of the organization responsible for creating the MSDS, date of issue, and emergency phone number.

Note that there are a number of items needed by a lab students (melting points, boiling points, etc.) not normally found in MSDS.

Other sources of information. MSDS are not available for all chemicals you can expect to use – or produce – in lab exercises; materials that are not sold in interstate commerce are not covered by the law. When seeking either safety information or physical data, also check:

- Bottle labels, including the original manufacturer's label and the ones we write when transferring materials to our own bottles (secondary containers). Pay careful attention to the labels on **consumer products** available in hardware, grocery & hobby stores. Some of these products can be extremely hazardous.
- Other web sites. The UCSD Department of Environment, Health & Safety maintains a good list of sites: *http://ehs.ucsd.edu*
- Reference books. A number of these are available for student use in the Undergraduate Labs Stockroom (3150 York Hall or 1104 NSB). Examples include the *Merck Index*, and the *CRC Handbook of Chemistry & Physics*. Various manufacturers' catalogs, such as the *Aldrich* catalog, contain a wealth of information. *Sax's Dangerous Properties of Industrial Materials* is available on-line *via* the UCSD Libraries reference collection.

For assistance in understanding and interpreting data, seek out

- your TA & instructor,
- Teaching Labs Safety Coordinator,
- Chemistry Department Safety Director,
- labs staff person assigned to your course, and
- safety professionals at UCSD Department of Environment, Health & Safety: *http://ehs.ucsd.edu*

STUDY GUIDE & PRACTICE QUESTIONS

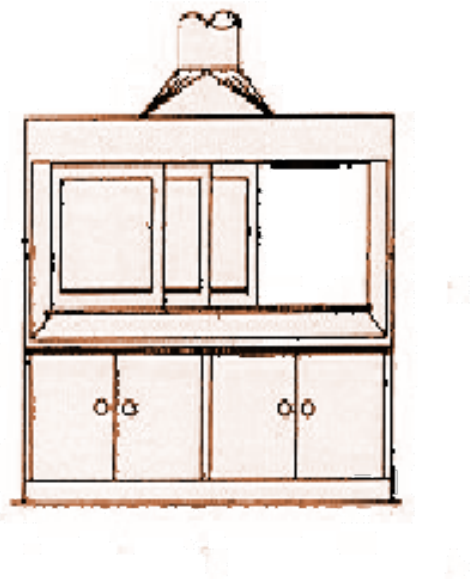
HAZARD COMMUNICATION Questions:

- Where can you locate the MSDS on a material you plan to use in lab?
- When is a student permitted to access the Undergraduate Labs' MSDS files?
- Where can you access MSDS files on the web?
- When is an employee allowed to use MSDS from the employer's files?

7. ENGINEERING CONTROLS

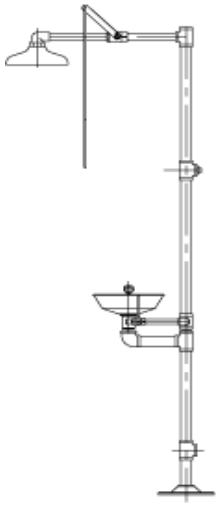
Engineering control is the level of built-in protection which distinguishes a properly constructed lab space from an ordinary office space that is being used for lab work. Engineering controls include fume hoods, air handling systems, showers & eyewashes, fire sprinklers, and fire walls & doors.

Fume hoods & air handling systems carry fumes and vapors away from a worker's breathing space. Our labs use 100% fresh air. An office or home ventilation system typically recirculates most of the air (to save energy) adding a small portion of fresh 'makeup air.' Our system supplies enough fresh air to allow the entire volume of air in the lab to be replaced ten to twelve times each hour.



Open hazardous volatile materials only in the fume hood. Close the hood sash as much as possible, opening the windows just enough to do your work while maintaining proper air flow. Set up equipment at least 6" back from the sash to capture fumes and vapors. Close lab doors to keep the air system balanced.

Fume hood alarms indicate a malfunction in this protective air handling system. Never try to silence an alarm without fixing the problem. When an alarm sounds, check to make sure the sash is properly positioned – this alone may silence the alarm, indicating that the problem is fixed. If the alarm continues, notify the lab staff so the fume hood can be repaired. Tape a note on the hood noting when the problem was reported & to whom. Use another hood until the broken one is fixed. If all alarms in one room are sounding, suspect a failure of the system. Report the alarms to the lab staff and delay any work that needs fume hoods.



Showers & eyewashes provide unheated domestic (drinking) water in massive quantities; use them to rinse off contamination on skin or extinguish fires on clothing (*see* **FIRST AID**). Since no drains are provided, expect the water to pool in the lab, soaking anything on the floor and making walkways slippery. Summon Facilities Management (53**4-2930**) to deal with the water as soon as possible.

Fire sprinklers are heat activated and respond one at a time – usually one sprinkler will extinguish a lab fire. In a larger fire, **fire walls & closed fire doors** provide a 1-hour *fire envelope,* delaying the spread of a fire and protecting both occupants & Emergency Responders. Keep the lab doors closed and always close them when leaving. In a fire, the walls and fire doors will contain the fire, allowing evacuation through the adjacent hallway. They also allow fire fighters to approach the room and set up their equipment before they are exposed to the fire.

ENGINEERING CONTROLS Questions:

- What are fume hoods for and how should they be used?
- Why are lab workers instructed not to prop open lab doors for fresh air?
- Suggest appropriate situations in which the emergency shower/eyewash would be helpful.
- Are all volatile materials hazardous?

8. PERSONAL PROTECTIVE EQUIPMENT (PPE)

The minimum level of safety protection necessary to work in the Undergraduate Teaching Labs is safety eyewear, closed shoes, and long (knee-length) lab coat. Students who arrive unprepared or inappropriately dressed will be dismissed until ready to work.

Appropriate clothing for lab workers (student, staff, TA and instructor) takes into account the chemical and physical hazards of lab work – the presence of corrosive and flammable materials as well as the use of open flames. For this reason, students who arrive unprepared or inappropriately dressed will be dismissed until ready to work.

Choose sturdy closed shoes and a long style (knee length) lab coat; wear the coat closed to protect skin and clothing; make sure shirt sleeves don't protrude beyond coat sleeves. We keep the labs cool so that long clothing (trousers and lab coats) is comfortable – if your lab is too warm, please let the staff know.

Flame retardant natural fibers, such as cotton, wool and linen, are preferred for lab wear. Synthetics fibers, such as nylon, tend to burn easily or melt onto skin and are particularly inappropriate for lab wear. Store lab coats in the lab or carry them folded in plastic bags to prevent spreading contamination. Wash lab coats separately from other laundry. Wearing a lab coat away from the lab area indicates a disregard for the health and safety of the community.

When working in lab, remove loose jewelry and remove or restrain very long or loose clothing. Manage long hair and scarves to prevent fire, contamination, or contact with moving parts of machines. (See **FIRE SAFETY.**)

Shoes that are closed all around are required to protect the feet from broken glass and chemical spills. Sandals, clogs and other open shoes are inappropriate. A closed shoe made of nonabsorbent material with a tread that would not slip on a wet floor is preferred. Be aware that sturdy boots or safety shoes are standard practice in many workplaces.

Light-weight disposable gloves, available in the labs, protect the hands from *incidental* contact with common lab chemicals and protect from dirt & abrasions. If your gloves are dirty, worn or contaminated, rinse and remove them, wash your hands and get new gloves. Unusually hazardous materials or extended contact will require greater protection; consult with lab staff if you suspect this will be necessary.

Always remove gloves and wash hands before leaving the lab or starting a new activity. Unskilled lab workers who forget to remove their gloves can carry hazardous materials to clean areas and contaminate others. If you see others wearing gloves in the halls or elevators, please remind them.

STUDY GUIDE & PRACTICE QUESTIONS




GOGGLES ----------SAFETY GLASSES ---------- Visorgogs®

NOTE that the item called *Visorgogs*® = glasses, not goggles.

Safety eyewear. *The Department of Chemistry & Biochemistry requires safety eye protection for all workers in all labs whenever anyone is doing lab work.* This Department rule allows for the use of a laboratory as a classroom for a lecture or quiz. As long as *no one in the room* is doing lab work, eye protection is not required; when the first person begins lab work, *everyone* (students, TAs, staff, instructors, and visitors) must don appropriate eye protection. (Visitors should check in with the Stockroom (3150 York Hall or 1104 NSB); they will be supplied with goggles or glasses, as well as protective clothing.)

The choice of appropriate eye protection (see illustration) is governed by several factors. **Safety glasses** provide protection from impact (as from broken glass) but little protection from liquids splashed into the face; they are appropriate for general (dry) lab work. **Chemical splash goggles** fit closely to the face and are vented indirectly to prevent a splash from reaching the eyes. Goggles purchased for other activities may not be appropriate for chemical work. Seek advice from the safety staff to be sure.

Chemical splash goggles are required when *anyone in a work area* is transferring more than a trivial amount of an eye hazardous substance. Note that everyone who might be affected by a spill in the area wears splash goggles until the procedure is completed, not just the person carrying or pouring the hazardous substance. In some laboratories, specific procedures with a high level of eye hazard are restricted to "goggles only" areas. There are cases where additional eye and face protection are warranted and face shields are available for these cases, but such cases rarely occur in student laboratories.

For simplicity and for the greatest measure of safety, a lab class may, at the option of the instructor, be designated a "goggles only" class. In recent terms, Chemistry 6BL and 143A have been "goggles only" – for students, staff, TAs, instructors, and visitors in these classroom. Check the class syllabus for current requirements.

More advanced lab students are expected to have both goggles and glasses and to be able to distinguish the situations in which each is appropriate. The lab TA and instructor will assist in developing judgment about such situations. Goggles are always appropriate.

The UCSD Bookstore and at the General Store Co-Op carry approved **chemical splash goggles** (*for example,* ENCON series 500) and approved **safety glasses** (*for example,* UVEX brand Ultraspec 2000 & 2001, Astro OTG 3001, and Astrospec 3000 series glasses). The Astro OTG3001 and Ultraspec2001 glasses are designed to fit over prescription glasses. The Undergraduate Labs Stockroom **does not lend** goggles or glasses to students.

STUDY GUIDE & PRACTICE QUESTIONS

Wash goggles and glasses frequently, as for any other personal item. Anti-fog cleaners (available in the Bookstore and in the Lab Stockrooms) provide some relief from fogging.

Contact Lenses: When worn with safety eyewear (goggles or safety glasses), contact lens wear is acceptable. Be aware that this is the UCSD Teaching Labs rule; some labs and some employers do not allow contact lenses.

Hearing protection. Excessive noise is not generally a concern in chemistry labs, but occasions arise when protection is necessary. Be aware that hearing protection is standard PPE in many industrial jobs and for any use of power tools (at home or at work). Hearing protection is rated by the amount of noise reduction (in decibels, dB) provided.

PPE at home. Many household and hobby materials are hazardous. Use protective equipment appropriate to the activity. Examples include gloves and goggles for wet chemicals, eye protection and hearing protection for target shooting or power tools, and sturdy boots for moving heavy materials.

STUDY GUIDE & PRACTICE QUESTIONS

PERSONAL PROTECTIVE EQUIPMENT (PPE) Questions:

- Distinguish between safety glasses and splash goggles; give the important similarities and differences. Give an example of an activity where each is appropriate.
- Contact lenses are not recommended for use in the Undergraduate Laboratories.
    - __ True
    - __ False
- To protect your eyes when mixing strong caustics or acids, it is recommended you wear:
    - __ Safety glasses with side shields
    - __ Safety goggles
    - __ A face shield with safety glasses or goggles
    - __ A face shield
- When are splash goggles required in the Chemistry Undergraduate Labs?
- Is a Lab Supervisor (Instructor or TA) permitted to make a safety rule which is stricter than the Department rule?
- What eye protection is required in your lab class?
- Do hazardous chemicals used at home require protective equipment? Why/why not?
- Describe how you will apply the safety knowledge you learned from this course to your work environment or your teaching environment.
- When should you wear protective gloves in lab?
- What happens to students who arrive for lab classes in sandals or shorts?
- What is the minimum appropriate level of personal protection that should be worn in the Teaching Labs?
- Does the Undergraduate Labs Stockroom lend goggles to students who forget? What if it's your birthday?
- When are you REQUIRED to wear your safety glasses (or goggles) by departmental policy?
- What is the minimum eye protection required when you pour 25 mL of a hazardous liquid or are in danger of being splashed?

9. WASTE MANAGEMENT

Wastes generated in the labs range from nearly innocuous (towels wet with water) to hazardous (flammable or toxic materials). Careful disposal of wastes protects the safety of all workers, including the essential maintenance staffs who support our lab work. Unless you have specific instructions to “dispose to drains,” assume all experimental wastes are hazardous and look for appropriate waste containers.

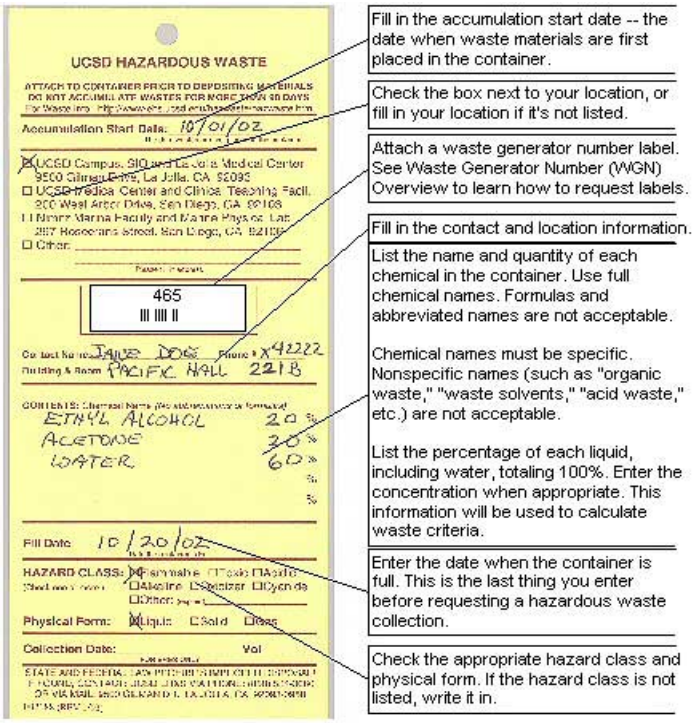
Sharps are any item that could cut through a plastic trash bag. These items include broken glass and fine glass pipettes, needles, razor blades and any other item with a sharp edge or point. Special containers are provided in the labs for their disposal. Place broken glass and other sharps in the labeled cardboard containers provided; capillary tubes and pipettes, can be placed in the large broken glass boxes or they may have their own special disposal containers. Needles are seldom used in the Undergraduate Labs, but present a special public health problem in clinical labs. In any lab that uses needles, especially to draw blood, workers receive training in proper disposal.

Hazardous waste chemicals are disposed to containers provided and labeled by the lab staff. Keep each waste container in a tray (in case of spills or leaks) and keep them closed at all times, except when actually adding waste. Leaving a waste container open in a hood (". . . *because we're all using it . . . "*) does not meet this rule; it must be closed by each worker after each addition of waste. This practice minimized the chance of spills, the evaporation of volatile wastes, and fines by regulatory agencies.

STUDY GUIDE & PRACTICE QUESTIONS

Waste bottles are typically 4- to 20-liter bottles with descriptive labels. In addition, each will have a UCSD Hazardous Waste Tag, as required by law. If the tag is missing or defaced, please let the staff know so it can be replaced.

If a waste bottle is full, cap it securely and leave it in its tray; and request another bottle for that waste from the lab staff. If you don't see a container appropriate for your waste, ask your TA or the lab staff member assigned to your lab.



Excess chemicals which will not be used are *never* returned to the stock bottle (due to the chance of contamination); try to find someone who still needs the item, then dispose of the remaining excess in the appropriate waste container.

WASTE MANAGEMENT Questions:

- What is the best way to deal with broken glass with a hazardous solid residue?
- What should you do with a hazardous waste generated in the Teaching Labs?
- Why are you instructed never to return chemicals to stock bottles?
- What should you do with excess hazardous solid you will not use?
- You have your wash bottle of water, your spatula, and two containers of hazardous waste:
    a) *toxic solid you have synthesized, dried & weighed on filter paper and*
    b) *a mixture of liquids including acid, water, and metal ions.*

You also have three hazardous waste containers labeled:

1. *"DRY SOLIDS ONLY"*
2. *"LIQUID WASTE ONLY"*
3. *"ORGANIC SOLVENTS ONLY".*

What is your disposal strategy?

10. SPILL RESPONSE

Spill response requires an immediate assessment of the hazard presented by the spill. For this reason, *all spills and accidents* must be reported to the lab supervisor (TA or Instructor) without delay. All spills & accidents require Accident Reports. Avoid injury (or further injury) by keeping people out of spill area. Study the **FIRST AID** section carefully.

As in any accident, consider **life before property**. The first responders on the scene (student, TA, Instructor or staff) should render assistance to any injured persons whenever it is possible to do so without increasing the danger to others. Don't make a situation worse by involving or contaminating others. If the situation is too large or too hazardous to handle, evacuate the room and call for professional assistance. Close doors and post a sign on the door to prevent entry by unsuspecting workers.

Time before aid is often critical in minimizing injuries, so begin rinsing spills or rendering aid as soon as possible. Keep a work area clear for TA and Emergency Responders. Provide privacy and extra clothing as needed. If emergency shower is in use, move people who are not helping outside the lab, as floors will be slippery. Remain alert for instructions from the TA and give assistance wherever possible.

Spills on skin or in eye. Notify TA immediately while beginning **FIRST AID**. Seek medical assistance without delay. Give any information about contamination (substance and concentration) to paramedics or other Emergency Responders. TA or staff will check to see if student has an **EMERGENCY RESPONSE INFORMATION** form and give the unopened form to the Emergency Responders. Complete an Accident Report.

A large or volatile spill of a hazardous material requires **evacuation** of the lab and professional assistance. Notify the lab staff & EH&S about the nature & extent of the spill. Post signs (stocked in the Spill Kits) on the lab doors to avoid reentry by persons unaware of the spill. Complete an Accident Report.

A **mercury (Hg) spill** is a special case. Mercury is a neurotoxin and the primary route of exposure is inhalation of mercury vapor. If mercury is spilled in/on a *hot* environment (sand bath, oven or hot plate), evacuate the lab without delay & call for staff assistance. The vapor pressure of mercury (and the risk of exposure) rises quickly with rising temperature. If the mercury spill is *cold or room temperature*, the vapor pressure will be low and the risk of exposure minimal. Use the special cleanup equipment provided in the Spill Kits.

Other small hazardous spills may be cleaned using the materials in lab Spill Kits under the direction of the TA or Instructor. Choose appropriate PPE & follow instruction provided in the Spill Kit to absorb/neutralize spilled materials before collecting it for disposal. Complete an Accident Report.

STUDY GUIDE & PRACTICE QUESTIONS

Acid and base spills on inert surfaces (for spills on people, *see* **FIRST AID** and **Spills on skin or in eye**, above). Regardless of how small, spills must be THOROUGHLY CLEANED and NEUTRALIZED. Dilute the spill with water and neutralize acid with solid sodium bicarbonate. Use solid citric acid for base spills. After neutralizing the spill, rinse with water. When the spill appears to be clean, test the wet surface with pH test paper and repeat as needed to assure surfaces are neutral. For a spill that runs off a lab bench, be sure to check inside drawers for additional liquids. Sodium bicarbonate and citric acid can be found in the lab Spill Kits.

Dispose of all used waste paper (towels and Kimwipes) in trash receptacles. Paper soaked with chemicals should be placed in solid hazardous waste containers, not in the general trash. Rinse broken glass before placing it in the broken glass receptacles.

Used cleanup materials. Seal used/contaminated materials in plastic bags provided in the Spill Kits, label the bags (contents, hazards, date) and leave them in the lab's hazardous waste collection area. Notify staff so they can arrange collection & disposal. Request replacement cleanup materials (at Stockroom Service Window, 3150 York Hall or 1104 NSB) and replace the used items, leaving the Spill Kit fully stocked.

SPILL RESPONSE Questions:

- How should you dispose of the sludge created when neutralizing a small acid spill with sodium bicarbonate?

  a. dump it in the trash bin.
  b. collect it in a plastic bag and store in the hazardous waste area of the lab.
  c. leave it to dry on the work bench, then dump in trash bin.
  d. leave it to dry on the work bench, then store in the hazardous waste area of the lab.

- How can you assure that all acid has been cleaned from a spill on the floor?
- Who is available to assist you in cleaning a spill of hazardous materials in your lab?
- Where is the Spill Kit kept in your lab?
- After cleaning a spill, how should you dispose of the leftover broken glass?
- How can you assure the Spill Kit will have what you need in case of a chemical spill?
- How big a spill is too big for a student & TA to clean up?